TETRA TECH

July 16, 2012

Mr. Randy Schademann
On-Scene Coordinator
U.S. Environmental Protection Agency, Region 7
901 North 5th Street
Kansas City, Kansas 66101

Subject: **Quality Assurance Project Plan**
Removal Action at Radiation – Standard Products Site, Inc. (Former)
Wichita, Kansas
CERCLIS ID KSN000705966
U.S. EPA Region 7 START 3, Contract No. EP-S7-06-01; Task Order No. 0299
Task Monitor: Randy Schademann, On-Scene Coordinator

Dear Mr. Schademann:

Tetra Tech EM Inc. is submitting the attached Quality Assurance Project Plan for a Removal Action at the Radiation – Standard Products site in Wichita, Kansas. If you have any questions or comments, please contact the project manager at (816) 412-1775.

Sincerely,

Robert Monnig, PE
START Project Manager

Ted Faile, PG, CHMM
START Program Manager

Enclosures

cc: Roy Crossland, EPA Region 7 (Cover letter only)

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Superfund

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Tetra Tech EM Inc.
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Tel 816.412.1741 Fax 816.410.1748 www.tetratech.com

X9004.12.0299.000

QUALITY ASSURANCE PROJECT PLAN
FOR A REMOVAL ACTION AT THE
RADIATION – STANDARD PRODUCTS, INC. SITE (FORMER)
WICHITA, KANSAS

CERCLIS ID KSN000705966

Superfund Technical Assessment and Response Team (START) 3 Contract
Contract No. EP-S7-06-01, Task Order 0299

Prepared For:

U.S. Environmental Protection Agency
Region 7
Superfund Division
901 N. 5th Street
Kansas City, Kansas 66101

July 16, 2012

Prepared By:
Tetra Tech EM Inc.
415 Oak Street
Kansas City, Missouri 64106
(816) 412-1741

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Addendum to the QAPP for Superfund Integrated Site Assessment and Targeted Brownfields Assessment Activities (July 2007)
for the Radiation – Standard Products, Inc. Site (Former)

Project Information:

Project Name: Radiation – Standard Products, Inc. Site (Former)		**County:** Wichita	**State:** KS
EPA Project Manager: Randy Schademann		**START Project Manager:** Rob Monnig	
Approved By: [signature]		**Prepared For:** EPA Region 7 Superfund Division	
Title: START Project Manager	**Date:** 7/16/12		
Approved By: [signature]			
Title: START Program Manager	**Date:** 7/16/12		
Approved By: David O Zimmer		**Prepared By:** Rob Monnig	
Title: START QA Manager	**Date:** 7/16/12	**Date:** July 2012	
Approved By: [signature]			
Title: EPA Project Manager	**Date:** 7/17/12	**Tetra Tech START Project Number:** 103DX9004L120299.000	
Approved By: Diane Harris (approved w/ conditions)			
Title: EPA Region 7 QA Manager	**Date:** 07/18/2012		

1.0 Project Management:

1.1. Distribution List

EPA—Region 7: Randy Schademann, EPA Project Manager
Diane Harris, EPA Region 7 QA Manager

Tetra Tech START: Rob Monnig, Project Manager
Kathy Homer, QA Manager

1.2. Project/Task Organization

Randy Schademann, of the EPA Region 7 Superfund Division, will be the EPA project manager for the activities described in this QAPP. Rob Monnig, of Tetra Tech EM Inc., will be the START project manager for field activities.

1.3. Problem Definition/Background:

Description: This site-specific Quality Assurance Project Plan form is prepared as an addendum to the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007), and contains site-specific data quality objectives for the sampling activities described herein.

☒ Description attached.
☐ Description in referenced report: ____________ Title ____________ Date

1.4. Project/Task Description:

☐ CERCLA PA ☐ CERCLA SI ☐ Brownfields Assessment ☒ Removal Action
☐ Other (description attached): ☐ Pre-CERCLIS Area Screening ☐ Removal Site Evaluation

Other Description:

Schedule: Field work is anticipated to begin the week of July 16, 2012, and is anticipated to take one week.

☐ Description in referenced report: ____________ Title ____________ Date

1.5. Quality Objectives and Criteria for Measurement Data:

a. Accuracy:	☒ Identified in attached table.
b. Precision:	☒ Identified in attached table.
c. Representativeness:	☒ Identified in attached table.
d. Completeness*:	☒ Identified in attached table.
e. Comparability:	☒ Identified in attached table.

Other Description:

*A completeness goal of 100 percent has been established for this project. If the completeness goal is not met, EPA may still be able to make decisions based on any or all of the remaining validated data.

1.6. Special Training/Certification Requirements:

☒ OSHA 1910 ☒ Special Equipment/Instrument Operator (describe below): ☒ Other (describe below):

Along with the training listed above, familiarization with radiation screening instrumentation and procedures will be necessary for the Tetra Tech START team.

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1.7. Documentation and Records:

☒ Field Sheets ☒ Daily Log ☐ Trip Report ☒ Area Maps ☐ Video
☒ Chain of Custody ☒ Health and Safety Plan ☒ Letter Report ☒ Photos

☒ Sample documentation will follow EPA Region 7 SOP 2420.05.

☒ Other: Analytical information will be handled according to procedures identified in Table 2.

2.0 Measurement and Data Acquisition:

2.1. Sampling Process Design:

☐ Random Sampling ☐ Transect Sampling ☒ Biased/Judgmental Sampling ☐ Stratified Random Sampling
☐ Search Sampling ☒ Systematic Grid ☐ Systematic Random Sampling ☐ Definitive Sampling
☐ Screening w/o Definitive Confirmation ☒ Screening w/ Definitive Confirmation
☒ Sample Map Attached

☒ Other (Provide rationale behind each sample): See Attachment A for additional sampling information.

Real-time field sampling will be judgmental, in accordance with the Guidance for Performing Site Inspections Under CERCLA, OSWER Directive #9345.1-05, September 1992; and Removal Program Representative Sampling Guidance, Volume 1: Soil, OSWER Directive 9360.4-10, November 1991. Judgmental sampling is the subjective (biased) selection of sampling locations based on historical information, visual inspection, and the best professional judgment of the sampler. Surface and subsurface soil will be field screened for gamma radiation with real-time instruments.

A final status radiological survey following removal activities will be conducted using a systematic grid, in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), Revision 1, August 2000. Soil samples will be submitted for laboratory radionuclide analysis.

See Attachments A through D for additional site-specific information and maps.

Sample Summary Location	Matrix	# of Samples*	Analysis
Within removal areas for confirmation analysis, and within non-impacted areas to determine background levels	Soil	49	Radionuclides (gamma spectrometry, radium-226)

*NOTE: Ten background/QC samples are included with these totals. See Table 1 for a complete sample summary.

2.2. Sample Methods Requirements:

Matrix	Sampling Method	EPA SOP(s) or other Method
Soil	Soil samples will be collected from 0 to 4 inches below ground surface using disposable stainless steel spoons, and transferred to appropriate sample containers.	SOP 4231.2012

☐ Other Description:

2.3. Sample Handling and Custody Requirements:

☒ Samples will be packaged and preserved in accordance with procedures defined in Region 7 EPA SOP 2420.06.
☒ COC will be maintained as directed by Region 7 EPA SOP 2420.04.
☐ Samples will be accepted according to Region 7 EPA SOP 2420.01.
☒ Other (Describe): Samples will be accepted according to procedures established by the START-contracted laboratory.

2.4. Analytical Methods Requirements:

☒ Identified in attached table.
☒ Rationale: The requested analyses have been selected based on historical information about the area and program experience with similar types of sites.
☐ Other (Describe):

2.5. Quality Control Requirements:

☐ Not Applicable
☒ Identified in attached table.
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Field QC Samples: For this investigation, no field QC samples will be required to obtain valid data for the removal action.
☐ Other (Describe):

2.6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Testing, inspection, and maintenance of analytical instrumentation will proceed in accordance with the previously referenced SOPs or manufacturers' recommendations. Testing, inspection, and maintenance of field instruments (radiation screening instruments, GPS units, etc.) will proceed in accordance with manufacturers' recommendations.

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2.7. Instrument Calibration and Frequency:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Calibration of laboratory equipment will be performed as described in the previously referenced SOPs or manufacturers' recommendations.
☒ Other (Describe): Calibration of field instruments (radiation screening instruments, etc.) will be conducted in accordance with manufacturers' recommendations.

2.8. Inspection/Acceptance Requirements for Supplies and Consumables:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☐ All sample containers will meet EPA criteria for cleaning procedures for low-level chemical analysis. Sample containers will have Level II certifications provided by the manufacturer in accordance with pre-cleaning criteria established by EPA in Specifications and Guidelines for Obtaining Contaminant-Free Containers.
☒ Other (Describe): Soil samples collected for radionuclide analysis will be collected into Ziploc®, or similar, bags.

2.9. Data Acquisition Requirements:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Previous data or information pertaining to the area (including other analytical data, reports, photos, maps, etc., that are referenced in this QAPP) has been compiled by EPA or its contractors from other sources. Some of that data has not been verified by EPA or its contractors; however, that unverified information will not be used for decision-making purposes by EPA without verification by an independent professional qualified to verify such data or information.
☐ Other (Describe):

2.10. Data Management:

☐ All laboratory data acquired will be managed in accordance with Region 7 EPA SOP 2410.01E.
☒ Other (Describe): All laboratory data acquired will be managed according to procedures established by the EPA-approved laboratory.

3.0 Assessment and Oversight:

3.1. Assessment and Response Actions:

☒ Peer Review ☒ Management Review ☐ Field Audit ☐ Lab Audit
☒ Assessment and response actions pertaining to analytical phases of the project are addressed in Region 7 EPA SOPs 2430.06 and 2430.12.
☐ Other (Describe):

3.1A Corrective Action:

☒ Corrective actions will be at the discretion of the EPA project manager whenever problems appear that could adversely affect data quality or resulting decisions affecting future response actions pertaining to the area.
☐ Other (Describe):

3.2. Reports to Management:

☐ Audit Report ☐ Data Validation Report ☐ Project Status Report ☐ None Required

☒ A letter report describing the sampling techniques, locations, problems encountered (with resolutions to those problems), and interpretation of analytical results will be prepared by START and submitted to the EPA.
☒ Reports will be prepared in accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☐ Other (Describe):

4.0 Data Validation and Usability:

4.1. Data Review, Validation, and Verification Requirements:

☐ Identified in attached table.
☒ Data review and verification will be performed in accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☐ Data review and verification will be performed by a qualified analyst and the laboratory's section manager as described in Region 7 EPA SOPs 2410.10, 2430.06, and 2430.12.
☒ Other (Describe): Data review and verification will be performed in accordance with procedures established by the START-contracted laboratory.

4.2. Validation and Verification Methods:

☐ Identified in attached table.
☐ The data will be validated in accordance with Region 7 EPA SOPs 2410.10, 2430.06 and 2430.12.
☒ The EPA project manager will inspect the data to provide a final review. The EPA project manager will review the data for laboratory spikes and duplicates, laboratory blanks, and field blanks to ensure the data are acceptable. The EPA project manager will compare the sample descriptions with the field sheets for consistency, and will ensure appropriate documentation of any anomalies in the data.
☒ Other (Describe): The data will be validated in accordance with procedures established by the START-contracted laboratory.

4.3. Reconciliation with User Requirements:

☐ Identified in attached table.
☒ If data quality indicators do not meet the project's requirements as outlined in this QAPP, the data may be discarded and re-sampling or re-analysis of the subject samples may be required by the EPA project manager.
☐ Other (Describe):

Region 7 Superfund Program Addendum to the QAPP for Superfund Integrated Site Assessment and Targeted Brownfields Assessment Activities (July 2007) for the Radiation – Standard Products, Inc. Site (Former)							
Table 1: Sample Summary							
Project Name: Radiation – Standard Products, Inc. Site (Former)				**Location:** Wichita, Kansas; see Attachment B, Figure 1			
START Project Manager: Rob Monnig				**Activity/ASR #:** Not Applicable (START-contracted laboratory)			**Date:** July 2012
No. of Samples	**Matrix**	**Location**	**Purpose**	**Depth or other Descriptor**	**Requested Analysis**	**Sampling Methods**	**Analytical Method**
39	Soil	Within removal area	To determine whether the site can be released for unrestricted use following cleanup activities	Surface soils (0-4 inches bgs)	Radionuclides (gamma spectrometry, radium-226)	EPA SOP 4231.2012	See below
10	Soil	Collected from non-impacted areas on or near the site	To determine background concentrations of radionuclides.	Surface soils (0-4 inches bgs)	Radionuclides (gamma spectrometry, radium-226)	EPA SOP 4231.2012	See below

Note:

Analytical methods are as follows: gamma spectrometry (DOE HASL 300 4.5.2.3); radium-226 (by bismuth ingrowth and gamma spectrometry using method DOE EML HASL 300 4.5.2.3).

Region 7 Superfund Program Addendum to the QAPP for Superfund Integrated Site Assessment and Targeted Brownfields Assessment Activities (July 2007) for the Radiation – Standard Products, Inc. Site (Former)								
Table 2: Data Quality Objective Summary								
Project Name: Radiation –Standard Products, Inc. Site (Former)			**Location:** Wichita, Kansas; See Attachment B, Figure 1					
START Project Manager: Rob Monnig			**Activity/ASR #:** Not Applicable (START-contracted laboratory)				**Date:** July 2012	
Analysis	**Analytical Method**	**Data Quality Measurements**					**Sample Handling Procedures**	**Data Manage-ment Procedures**
		Accuracy	**Precision**	**Representativeness**	**Completeness**	**Comparability**		
SOIL								
Radionuclides (gamma spectrometry, radium-226)	see Table 1	per analytical method	per analytical method	Schematic sampling in accordance with the *Multi-Agency Radiation Survey and Site Inspection Manual* (MARSSIM). See Attachment C.	100%	Standardized procedures for sample collection and analysis will be used.	See Section 2.3 of QAPP form.	See Section 2.10 of QAPP form.

ATTACHMENT A

SITE-SPECIFIC INFORMATION FOR THE RADIATION – STANDARD PRODUCTS, INC. SITE (FORMER)

INTRODUCTION

The Tetra Tech EM Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) has been tasked by the U.S. Environmental Protection Agency (EPA) Region 7 Superfund Division to assist with a removal action (RA) at the Radiation – Standard Products, Inc. (Standard Products) site in Wichita, Kansas. The former Standard Products facility was the location of an aircraft instrument repair shop in the 1950s and 1960s (Kansas Department of Health and Environment [KDHE] 2006). An investigation at the site by KDHE, reported in March 2006, identified radium-226 impacted soil on the former Standard Products site (KDHE 2006).

RA activities will include excavation of radium-impacted soil. Post-removal soil samples will be collected for laboratory analysis for radionuclides. This quality assurance project plan (QAPP) identifies site-specific features and addresses elements of the sampling strategy and analytical methods proposed for this investigation. Post-removal data will be analyzed in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) to determine if the area can be released for unrestricted use (EPA 2000).

AREA LOCATION/DESCRIPTION

The Standard Products site is in Wichita, Kansas, in the southeast quarter of Section 36, Township 25 South, Range 1 West (see Attachment B, Figure 1). The site includes several parcels, including 650 East Gilbert Street, the location of the former Standard Products facility, and adjoining parcels where radiologically impacted soil has been identified, including an alley, a private residence at 920 S. St. Francis Street, and the Guadalupe Clinic at 940 S. St. Francis Street (see Attachment B, Figure 2). Radium-impacted soil at the 920 S. St. Francis Street parcel was addressed during a RA in July 2009. The approximate center of the 650 East Gilbert Street parcel is at the following coordinates: 37.674880 degrees north latitude and 97.330500 degrees west longitude. The 650 E. Gilbert Street parcel occupies approximately 2.67 acres and is the location of a single 11,000-square-foot warehouse currently occupied by Phillips Southern Electric. The 940 S. St. Francis Street parcel is a single-story brick building occupied by the Guadalupe Clinic, a community healthcare clinic.

PREVIOUS INVESTIGATIONS

KDHE performed a Unified Focus Assessment (UFA) at the Standard Products site in 2006. An initial screening survey of the property by KDHE identified several areas with total gamma radiation readings above background. The maximum screening result in this area was 17,000 microRoentgens per hour

(μR/hr). Laboratory results indicated a maximum radium-226 detection of 81,800 picoCuries per gram (pCi/g) (KDHE 2006).

In February 2009, EPA tasked START to conduct a Removal Site Evaluation (RSE) to determine the extent of radium contamination (and associated radionuclides) in surface and subsurface soils at the former Standard Products facility. RSE activities at the site in March 2009 included a surface soil gamma survey and collection of surface and subsurface soil samples. During the RSE activities, areas with total gamma radiation readings above background were identified at several areas of the site (see Attachment B, Figure 3). Laboratory results indicated a maximum radium-226 detection of 302 picocuries per gram (pCi/g) in a soil sample collected from the 650 East Gilbert Street parcel (Tetra Tech 2009). Figure 3 in Attachment B depicts the anticipated areas of excavation to remove soil exceeding the EPA-determined action level.

Based on the results of investigations by KDHE and EPA/START, an RA was determined warranted to reduce the risk to occupants of the site. EPA has established a time-critical RA level for Ra-226 of 5 pCi/g above background in surface soil. Based on analysis of the background samples, the estimated Ra-226 background concentration in soil is approximately 2 pCi/g.

SAMPLING STRATEGY AND METHODOLOGY

Under this task order, START will conduct real-time monitoring in the study area to delineate the extent of impacted surface soil and to guide the removal. The proposed real-time sampling scheme for this project is judgmental (based on the best professional judgment of the sampling team), in accordance with the *Removal Program Representative Sampling Guidance*, Volume 1: Soil, Office of Solid Waste and Emergency Response (OSWER) Directive 9360.4-10, November 1991. After soil excavation is complete, a final status radiological survey will proceed in accordance with the MARSSIM, Revision 1, August 2000 (EPA 2000). Soil samples collected during this survey will be submitted for laboratory radionuclide analysis.

Field procedures will follow standard operating procedures (SOP) outlined in the QAPP. Field activities will include real-time monitoring of surface soils and collection of soil samples for laboratory analysis. Air will be monitored during the surface soil excavation. Descriptions of the sampling strategy and procedures are discussed below.

Real-Time Monitoring for Gamma Activity

Prior to excavation, START will survey surface soils at the site for gross gamma activity, scanning the surface soil in a serpentine pattern. The detector will be held approximately 6 inches above the ground surface while the surveyor moves the detector at approximately 1 to 2 feet per second. These scanning measurements, along with measurements obtained during previous investigations, will be used to guide excavation of contaminated surface soils. Excavation of surface soils will continue until scanning measurements of gross gamma activity indicate that the EPA-established action level of 5 pCi/g above background for Ra-226 has been achieved. When the final depth of excavation is reached, START will conduct a Final Status Survey (FSS).

Final Status Radiological Survey

The FSS will accord with MARSSIM guidance (EPA 2000). An FSS is performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use or, where appropriate, for use with designated limitations. The survey provides data to demonstrate that each radiological parameter does not exceed the established derived concentration guideline level (DCGL) for average concentration over a wide area ($DCGL_W$). The $DCGL_W$ for the site is the action level of 5 pCi/g above background for Ra-226. The FSS plan includes a reference coordinate system, the survey units, the number and location of samples, scanning survey procedures, and calculation of the minimum detectable concentration for the scanning survey. An FSS sampling design plan is included in Appendix C.

The FSS survey will include both a real-time scanning survey and collection of soil samples on a systematic grid for laboratory analysis. Before the FSS survey begins, the site will be divided into individual survey units, and each unit will be classified as a Class 1, 2, or 3 area based on potential for residual contamination. The survey units will be classified based on the site operating history and previous survey and sampling data. The survey units are classified to establish the level of survey coverage needed for a particular area based on potential for residual contamination. MARSSIM provides the following descriptions for Class 1, 2, and 3 areas.

- Class 1 areas: Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological surveys). Examples of Class 1 areas include: (1) site areas previously subjected to remedial actions, (2) locations where leaks or spills are known to have occurred, (3) former burial or disposal sites, (4) waste storage sites, and (5) areas with contaminants in discrete solid pieces of material with high specific activity. Areas containing contamination exceeding the $DCGL_W$ prior to remediation should be classified Class 1.

- Class 2 areas: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$. To justify changing an area's classification from 1 to 2, the existing data (from scoping surveys, or characterization surveys) should provide a high degree of confidence that no individual measurement would exceed the $DCGL_W$. Examples of areas that might be classified as Class 2 for the final status survey include: (1) locations where radioactive materials were present in an unsealed form (e.g., process facilities), (2) potentially contaminated transport routes, (3) areas downwind from stack release points, (4) upper walls and ceilings of some buildings or rooms subjected to airborne radioactivity, (5) areas where low concentrations of radioactive materials were handled, and (6) areas on the perimeter of former contamination control areas.

- Class 3 areas: Any impacted areas not expected to contain any residual radioactivity, or expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on site operating history and previous radiological surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but about which insufficient information is available to justify a non-impacted classification.

Following removal, EPA and START will divide the site into survey units and classify each unit. Anticipated is establishment of three Class 1 survey units that include all areas where soil will have been excavated. One Class 3 unit will be established as a buffer zone around the Class 1 survey units. Following removal, to verify that no areas of elevated activity remain, a 100-percent scan of soils in the Class 1 survey units will occur. If an area of elevated activity is detected in a Class 1 area and is suspected to contain contamination exceeding the $DCGL_W$, additional actions would ensue to remove the suspected contamination, after which the area would be scanned again. In the Class 3 unit, scanning is to occur at random locations and within areas having greatest potential for residual contamination based on professional judgment (such as within drainage areas or areas downwind of the Class 1 unit). If an area of elevated activity is detected, the area would be flagged, investigated further, and all or part of the Class 3 unit would be reclassified as Class 1 or 2. The FSS sampling design plan describes the procedures and equipment for conducting the scanning surveys (see Appendix C).

Following the scanning survey, soil samples will be collected from the Class 1 units for laboratory analysis. In Class 3 areas, MARSSIM guidance allows for direct measurement using field instruments in lieu of soil sampling and laboratory analysis if the contamination is associated with gamma emitting radionuclides (because contamination is readily detectable with field instruments). Because Ra-226, a significant gamma emitter, is associated with the contamination at the site, direct measurements using field instruments will occur in the Class 3 unit in lieu of laboratory analysis.

Soil sampling within the Class 1 units will proceed at locations established by a systematic grid. The number of sampling locations has been predetermined based on application of a statistical method described in MARSSIM, and is independent of the size of the survey unit (see Appendix C). Because the number of sampling locations is predetermined, the grid spacing will be calculated in the field by dividing the number of pre-determined sampling locations by the area of the Class 1 unit. Per MARSSIM guidance, the Class 1 units will be limited to 2,000 square meters or less to ensure that each area is assigned an adequate number of data points. Following the MARSSIM guidance and using the following assumptions, collection of 13 soil samples in each Class 1 unit is expected to complete the FSS (39 soil samples if three Class 1 survey units are assumed). That number of soil samples was determined using the following example calculation:

1. The Lower Boundary of the Gray Region (LBGR) is set at 75% of the $DCGL_W$ (5 pCi/g): thus 3.75 pCi/g.
2. Calculation of the shift (Δ) is according to: $\Delta = DCGL_W - LBGR$; thus, Δ = 5 pCi/g – 3.75 pCi/g = 1.25 pCi/g.
3. The standard deviation (σ) of the data is anticipated at approximately 0.625 pCi/g.
4. Calculation of the relative shift thus proceeds as: Relative shift = Δ/σ = 1.25 pCi/g / 0.625 pCi/g = 2.0.
5. Calculation of the number of samples (n) per MARSSIM Table 5.3 (for contaminant present in the background) for a relative shift of 2.0 and Type I and Type II decision errors of 0.05 leads to a result of 13 samples.

Per MARSSIM guidance, if the survey unit area is relatively small (less than 100 square meters), the number of data points obtained from the statistical test may be unnecessarily large and not appropriate for the size of the unit. In this case, the number of samples may be based on judgment, rather than on the statistical techniques in MARSSIM.

Soil samples for laboratory radionuclide analysis will be collected from 0 to 4 inches bgs using a disposable stainless steel spoon, homogenized in a disposable aluminum pie pan, and placed in clean resealable plastic bags.

Air Monitoring

Air will be monitored to determine airborne concentrations of radioactive material during the excavation using four RADeCO® Model H-810 high-volume air samplers and a Ludlum® Alpha/Beta Sample Counter Model 3030. Air samples will be collected daily during removal activities. One air sampler will be along the site boundary or adjoining properties, and generally one will be in each cardinal direction. The samplers will be operated at flow rates of 4 to 6 liters per minute for approximately 8 hours each day. One paper filter sample will be collected from each air sampler daily and will be analyzed on site for radiological contamination using the Ludlum® Alpha/Beta Sample Counter Model 3030. These measurements will be used to estimate an exposure rate. These rates will be estimated using a spreadsheet provided by EPA (see Attachment D). In addition to monitoring airborne particles for radioactive activity, real-time air monitoring for gamma radiation will be conducted throughout the site using a Ludlum® Model 192.

ANALYTICAL METHODS

Appropriate containers and collection techniques will be employed during the field activities to help verify acquisition of representative analytical results. Samples will be submitted to a START-contracted laboratory for analysis according to the SOPs and methods referenced or described in the QAPP.

REFERENCES

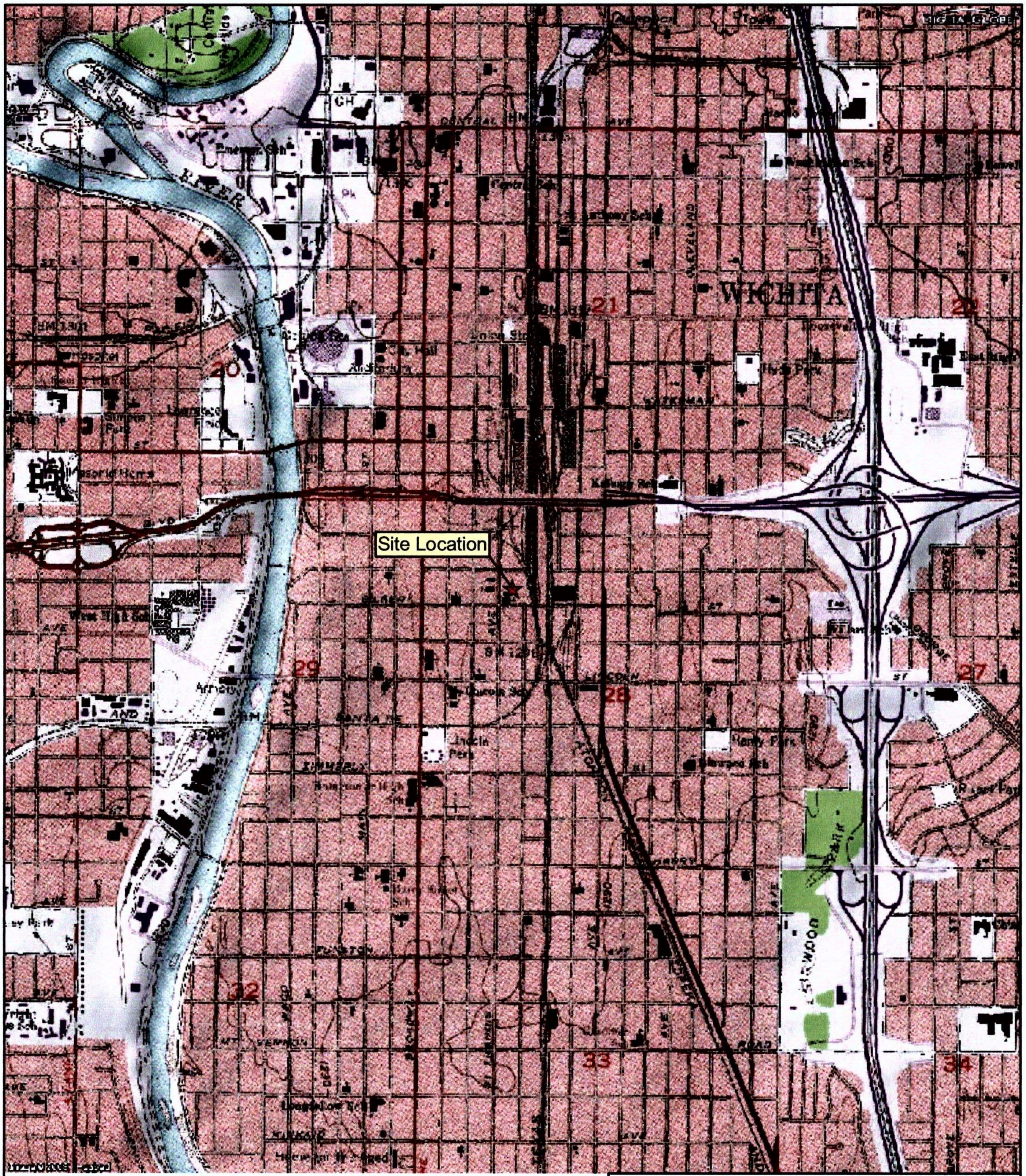
Kansas Department of Health and Environment (KDHE). 2006. Unified Focus Assessment Report, Standard Products, Inc. (Former), 650 East Gilbert, Wichita, Kansas. March.

Tetra Tech, Inc. (Tetra Tech). 2009. Removal Site Evaluation Trip Report, Revision 01, Radiation – Standard Products, Inc. (Former), Wichita, Kansas. August.

U.S. Environmental Protection Agency (EPA). 2000. *Multi-Agency Radiation Survey and Site Inspection Manual* (MARSSIM), Revision 1. EPA 402-R-97-016, Rev. 1. August.

ATTACHMENT B

FIGURES



N

1,000 0 1,000

Feet

Note: The Environmental Protection Agency does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any injury or loss resulting from the reliance upon the information shown.

Source: ImageConnect USGS 1:24k Topo Stack

Radiation - Standard Products, Inc. (Former)
Wichita, Kansas

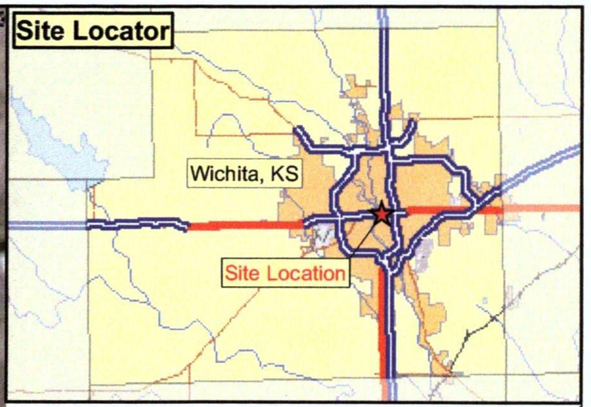
Figure 1

Site Location Map

TETRA TECH EM INC.

Date: 07/23/2009 Drawn By: Colin Willits Project No: 103DX9004L090131000

X:\G9004\0131\Projects\mxd\RSE_Figure1.mxd



Legend

Local Road

N

30 0 30

Feet

Note: The Environmental Protection Agency does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any injury or loss resulting from the reliance upon the information shown.

Source: Image Connect, Globe Xplorer Premium Stack, 2008
ESRI Media Kit, 2007

Radiation - Standard Products, Inc. (Former)
Wichita, Kansas

Figure 2
Site Layout Map

TETRA TECH EM INC.

Date: 07/23/2009 Drawn By: Colin Willits Project No: 103DI9004L090131000

Legend

- Soil Sample Location
- Proposed Area of Excavation

Gamma Survey Location

- < 17,659 cpm
  Below Investigation Level
- 17,659 - 31,794 cpm
  Investigation Level to 2x Background
- 31,794 - 47,691 cpm
  2x Background to 3x Background
- 47,691 - 63,588 cpm
  3x Background to 4x Background
- > 63, 588 cpm
  > 4x Background

cpm - counts per minute
sq ft - square feet

Notes: Measurements were collected using a Ludlum 3x3 detector.

The Investigation Level is the mean of background readings plus 10 times the standard deviation of the background readings. Areas that exhibited gamma activity above the Investigation Level were subjected to additional investigation following the initial surface soil gamma survey.

N

30 0 30
Feet

Note: The Environmental Protection Agency does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any injury or loss resulting from the reliance upon the information shown.

Source: RAT System Survey, March 2009
Image Connect, Globe Xplorer Premium Stack, 2008

Radiation - Standard Products, Inc. (Former)
Wichita, Kansas

Figure 3
Gamma Survey Results
and Soil Sampling Location Map

TETRA TECH EM INC.

Date: 07/06/2012 Drawn By: Nick Wiederholt Project No: 103DI9004L090131000

ATTACHMENT C

FINAL STATUS SURVEY SAMPLING DESIGN PLAN

FINAL STATUS SURVEY SAMPLING DESIGN PLAN
RADIATION – STANDARD PRODUCTS, INC. SITE (FORMER)
WICHITA, KANSAS

Introduction

The United States Environmental Protection Agency (EPA) has directed the Tetra Tech EM Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) to conduct a Final Status Survey (FSS) of surface soil at the Radiation – Standard Products, Inc. (Standard Products) site located in Wichita, Kansas, to determine if the surface soil can be released for unrestricted use. This FSS sampling design plan addresses collection of assessment data for this task.

Data Quality Objectives

The data quality objectives (DQO) process, as set forth in the EPA documents *Data Quality Objectives Process for Hazardous Waste Site Investigations* (EPA QA/G-4HW, January 2000, EPA/600/R-00/007) and *Guidance for the Data Quality Objectives Process* (EPA QA/G-4, August 2000, EPA/600/R-96/055) was followed to establish the data quality objectives for this FSS sampling design plan. An outline of the process and the outputs for this FSS sampling design plan are included below.

Step 1 - State the Problem

Problem

Results of the Removal Site Evaluation (RSE) and a previous Kansas Department of Health and Environment investigation indicate that surface soils at the site are impacted with radium-226 (Ra-226). Based on these results, areas of the site will be classified as Class 1 and Class 3 survey units in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance. The objective of this investigation is to conduct a FSS to determine if the area can be released for unrestricted use following removal activities.

Step 2 - Identify the Decision

Principal Study Questions

Is the mean residual surface soil contamination in the survey unit below the Derived Concentration Guideline Level-Average ($DCGL_W$) of 5.0 picocuries per gram (pCi/g) for Ra-226? Are all measurements in the survey unit below the Derived Concentration Guideline Level-Elevated Measurement Concentration ($DCGL_{EMC}$)?

Alternative Actions

If a survey unit fails to meet the release criteria, further investigations and remediation will be conducted. If a survey unit meets the release criteria, the survey unit will be released for unrestricted use. After remediation, the area will be reinvestigated to confirm that each survey unit meets the release criteria.

Decision Statement

Determine if each soil survey unit meets the release criteria.

Step 3 - Identify Inputs to the Decision

Information Required to Resolve the Decision Statement

1. Release criteria based on the $DCGL_W$ and $DCGL_{EMC}$.
2. Location and classification of each survey unit.
3. Location of reference areas and background levels.
4. The number of samples for each survey unit.
5. Appropriate measurement techniques with a minimum detectable concentration (MDC) at or below the release criteria, the $DCGL_W$ and $DCGL_{EMC}$.
6. Scanning data results from a 100% scanning survey over each Class 1 survey unit.
7. Posting plot of gamma radiation measurements.
8. Soil sample results for concentrations of Ra-226.
9. The spatial location of samples and measurements in each survey unit.
10. Data analysis of sample results for each survey unit to determine if the data pass the statistical tests for compliance with the $DCGL_W$.
11. Data analysis of scanning measurements for each survey unit to determine if measurements are less than the $DCGL_{EMC}$.

Sources of Information

Data and documentation generated during this investigation.

Information Needed to Establish the Action Levels

For this site, EPA has established a $DCGL_W$ of 5.0 pCi/g for Ra-226.

Confirm That Appropriate Methods Exist to Provide the Necessary Data

A laboratory has been arranged to perform the radioassay for the soil samples. Data generated will be definitive level quality. Field portable radiation instrumentation available in the EPA inventory can generate the required data for scanning surveys. Data will be field screening level quality.

Step 4 - Define the Study Boundaries

Characteristics that Define the Population of Interest

Activity of Ra-226 in pCi/g and gross gamma radiation measurements.

Spatial Boundaries of the Decision Statement

The boundaries of this investigation are defined as surface soil, from ground surface to 5 centimeters below ground surface. Three Class 1 survey units of approximately 2,500 square feet (ft^2) each are anticipated.

Temporal Boundaries of the Decision Statement

Completion of this investigation is anticipated within a three-week period.

Scale of Decision Making

The scale of decision making corresponds to the data collected from on-site surface soil samples and all gross gamma radiation measurements during scanning surveys.

Practical Constraints on Data Collection

No practical constraints exist for this investigation.

Step 5 - Develop a Decision Rule

Statistical Parameter that Defines the Population of Interest

Individual activity of Ra-226 and gross gamma radiation measurements will be used instead of a statistical parameter.

The Action Level for the Decision

For this site, EPA has established a $DCGL_W$ of 5 pCi/g for Ra-226.

Confirm the Action Level Exceeds Measurements Detection Limits

The action levels exceed detection limits for radioassay of soil samples and for gross gamma radiation measurements during scanning surveys that will be used during the investigation.

Decision Rule

Principal Study Questions for soil samples analyzed by the analytical laboratory:

If all samples are less than the $DCGL_W$, the survey unit will be released for unrestricted use.

If any sample equals or exceeds the $DCGL_W$, the data results will be evaluated based on the Wilcoxon Rank Sum (WRS) statistical test to determine if the survey unit can be released for unrestricted use. If a Class 1 survey unit fails the WRS statistical test, the survey unit data will be reevaluated to determine the appropriate actions. If a Class 2 survey unit fails the WRS statistical test, the survey unit classification will be reevaluated and if reevaluation of survey data indicates that the survey unit should be reclassified as a Class 1 survey unit, the survey unit will be assessed as a Class 1 survey unit.

Principal Study Questions for gross gamma radiation measurements:

If all surveyed locations in the survey unit are less than the $DCGL_W$, the survey unit is released for unrestricted use.

If any surveyed location in the survey unit equals or exceeds the $DCGL_W$, then determine the extent of contamination of the elevated area and reevaluate the classification of the survey unit if necessary. If reevaluation of survey data indicates that the survey unit should be reclassified as a Class 1 survey unit, the survey unit will be assessed in accordance with MARSSIM.

Step 6 - Specify the Limits on Decision Errors

Separate limits on decision errors for the $DCGL_W$ criteria and for the gross gamma radiation criteria were developed as detailed below.

$DCGL_W$ for Radium-226

Determine the Possible Range of the Parameter of Interest

The activity of Ra-226 contamination ranges from background (approximately 0.9 pCi/g) to approximately 81,800 pCi/g (the highest concentrations found by Kansas Department of Health and Environment).

Define Both Types of Decision Errors and Establish the True Nature for Each Decision Error

Decision Statement: Decision Errors Types I and II

Type I: Decide that a datum is less than the release criteria when, in fact, it is not.
Type II: Decide that a datum is above the release criteria when, in fact, it is not.

The first decision error occurs when the investigation results are erroneously reported below action levels, or observations and judgments are made that the true hazardous nature of the data does not warrant further action. This decision error could result from measurement error (i.e., errors in field screening such as an improper calibration, calculation errors, malfunction of instrument), monitoring or sampling error (i.e., incorrect use of instrument, improper sample handling, sample collection errors), and/or from judgment errors.

The second decision error occurs when the investigation results are erroneously reported above action levels or observations, and judgments are made that the true hazardous nature of the data does warrant further action. This decision error could result from measurement error (i.e., errors in field screening such as an improper calibration, calculation errors, malfunction of instrument), monitoring or sampling error (i.e., incorrect use of instrument, improper sample handling, sample collection errors), and/or from judgment errors.

The Type I and Type II decision errors are set at 0.05. The following calculations are used to determine the number of samples that must be collected and analyzed to obtain sufficient data to meet the decision errors. The following is a sample calculation. A new calculation will be conducted following removal activities, and the actual survey unit area as determined in the field will be used in the calculation.

1. The Lower Boundary of the Gray Region (LBGR) is set at 75% of the $DCGL_W$ (5 pCi/g), thus 3.75 pCi/g.

2. Calculate the shift. Shift (Δ) = $DCGL_W$ – LBGR; thus 5 pCi/g – 3.75 pCi/g = 1.25 pCi/g.

3. The standard deviation (σ) of the data is anticipated at approximately 0.625 pCi/g.

4. Calculate the relative shift. Relative shift = Δ/σ; thus 1.25 pCi/g / 0.625 pCi/g = 2.0.

5. Select the number of samples (n) per MARSSIM Table 5.3 (for contaminant present in the background) for a relative shift of 2.0 and Type I and Type II decision errors of 0.05. This is 13 samples.

6. Calculate the grid length for a triangular grid for 13 samples.

$$GridLength(L) = \sqrt{\frac{A}{0.866 n_{EA}}}$$

"A" is the survey unit area and n_{EA} is the number of samples.
Thus the square root of [2,500 square feet (ft^2) / (0.866 * 13)] = 15 feet

Consequences of the Decision Errors

Decision Statement: Decision Errors Types I and II
Type I: This decision error could result in a threat to human health and the environment.
Type II: This decision error could result in unnecessary expenditures for investigations or remediation.

Establish Which Decision Error Has the More Severe Consequences Near the Action Level

Decision Error Type I:
Decision error Type 1 has more severe consequences near the action levels, because the public or workers could be exposed to hazardous conditions potentially damaging to human health.

Define the Baseline Condition

Decision Error Type I:

H_0= Data exceed the release criteria and the survey unit will be reclassified as a Class 1 survey unit.

H_a= Data do not exceed the release criteria and the survey unit can be released for unrestricted use.

The null hypothesis is when data exceed the release criteria and the survey unit will be reclassified as a Class 1 survey unit. A false positive decision error occurs when the null hypothesis is falsely rejected. In this case, a false positive occurs if the decision maker decides that data do not exceed the release criteria, and that individual does not reclassify the survey unit as Class 1, when, in fact, it should be. A false negative occurs when the null hypothesis is falsely accepted.

Range of Possible Parameters Where the Consequence of a False Negative Decision Error is Relatively Minor (Grey Region)

A grey region of 75-100% of the action levels is acceptable for this investigation.

Tolerable Probability for Decision Errors
The decision error limits for this investigation are summarized in Table D-1.

Table D-1 Decision Error Limits for Radium

True Exposure (% of Action Level)	Decision Error Probability Goal	Type of Decision Error
<50	0.01	False Rejection
50-74	0.05	False Rejection
75-100	Grey Area	Grey Area
101-150	0.05	False Acceptance
>150	0.01	False Acceptance

Gross gamma radiation

Determine the Possible Range of the Parameter of Interest

Gross gamma radiation ranges from 9,000 counts per minute (cpm) (background) to approximately 100,000 cpm using a Ludlum 2x2 sodium iodide (NaI) detector.

Define Both Types of Decision Errors and Establish the True Nature for Each Decision Error

Decision Statement: Decision Errors Type 1 and Type 2

Decision Error Type 1: Decide that a datum is less than the release criteria when, in fact, it is not.
Decision Error Type 2: Decide that a datum is above the release criteria when, in fact, it is not.

A Type 1 decision error occurs when the investigation results are erroneously reported below action levels, or observations and judgments are made that the true hazardous nature of the data does not warrant further action. This decision error could result from measurement error (i.e., errors in field screening such as an improper calibration, calculation errors, malfunction of instrument), monitoring or sampling error (i.e., incorrect use of instrument, improper sample handling, sample collection errors), and/or from judgment errors.

A Type 2 decision error occurs when the investigation results are erroneously reported above action levels or observations, and judgments are made that the true hazardous nature of the data does warrant further action. This decision error could result from measurement error (i.e., errors in field screening such as an improper calibration, calculation errors, malfunction of instrument), monitoring or sampling error (i.e., incorrect use of instrument, improper sample handling, sample collection errors), and/or from judgment errors.

The Type 1 and Type 2 decision errors are 0.05. Individual measurements will not be collected. Gross gamma radiation will be measured by scanning the soil survey unit at a specific scan speed. Gamma measurements will fluctuate rapidly. The technician will determine if any location exceeds the $DCGL_{EMC}$ by observing the instrument meter dial.

Consequences of the Decision Errors

Decision Statement: Decision Errors 1 & 2

1: This decision error could result in a threat to human health and the environment.
2: This decision error could result in unnecessary expenditures for investigations or remediation.

Establish Which Decision Error Has the More Severe Consequences Near the Action Level

Decision Error 1:

Decision error 1 has more severe consequences near the action levels because the public or workers could be exposed to hazardous conditions potentially damaging to human health.

Define the Baseline Condition

Decision Error 1:

H_o= Data exceed the release criteria and the survey unit will be reclassified as a Class 1 survey unit.

H_a= Data do not exceed the release criteria and the survey unit can be released for unrestricted use.

The null hypothesis is when data exceed the release criteria and the survey unit will be reclassified as a Class 1 survey unit. A false positive decision error occurs when the null hypothesis is falsely rejected. In this case, a false positive occurs if the decision maker decides that data do not exceed the release criteria and that individual does not reclassify the survey unit as Class 1, when in fact, it should be. A false negative occurs when the null hypothesis is falsely accepted.

Range of Possible Parameters Where the Consequence of a False Negative Decision Error Are Relatively Minor (Grey Region)

A grey region of 75-100% of the action levels is acceptable for this investigation.

Tolerable Probability for Decision Errors

The decision error limits for this investigation are summarized in Table D-2.

Table D-2. Decision Error Limits for Gamma Radiation

True Exposure (% of Action Level)	Decision Error Probability Goal	Type of Decision Error
<50	0.01	False Rejection
50-74	0.05	False Rejection
75-100	Grey Area	Grey Area
101-150	0.05	False Acceptance
>150	0.01	False Acceptance

Step 7 - Optimize the Design for Obtaining Data

All sampling, analytical, and quality assurance activities will proceed under an EPA-approved Quality Assurance Project Plan (QAPP). The QAPP will be completed and approved prior to sample collection. Sampling activities and deviations from the QAPP will be documented in a field log book. Prior to sample collection, START personnel should review sampling procedures and relevant quality assurance and quality control required for the selected methods.

Sampling Design

The sampling design has been developed to generate the appropriate data to determine if the surface soil survey unit can be released for unrestricted use. The generated data will be analyzed by an appropriate statistical methodology in accordance with MARSSIM. The sampling design consists of two activities, collecting samples for laboratory analysis and performing scanning surveys. The combination of sampling and scanning provides an integrated FSS design as discussed in MARSSIM. The sampling and analysis results will be compared to the release criterion, i.e., the $DCGL_W$. A systematic sampling grid and the statistical test of the results are based on the assumption that the contamination is uniformly distributed throughout the survey unit.

Scanning survey measurements are collected for compliance with the $DCGL_{EMC}$. This survey is performed to determine if elevated areas of contamination are located in the survey unit. By scanning the survey unit, small areas of contamination can be detected.

Scanning Survey

MARSSIM recommends performing a scanning survey over 100% of a Class 1 survey unit and between 10% and 100% for Class 2 survey units. The key component to the design of a scanning survey is the determination of the scanning rate, based on achieving a specified scan minimum detectable concentration (MDC). MARSSIM discusses the determination of the scan MDC for gamma emitting radioisotopes in soil (Section 6.7.2.1, MARSSIM 2000).

Site specific variables used in the determination of the scan minimum detectable concentration (MDC) are as follows:

- Radionuclide = Ra-226
- Diameter of elevated area = 50 cm
- Depth of elevated area = 5 cm
- Detector = Ludlum Model 44-10, 2" by 2" sodium iodide scintillator
- Detector background = 9,000 cpm (exact value will be determined in field)
- Ra-226 $DCGL_W$ = 5.0 pCi/g
- Background Ra-226 = 2 pCi/g
- Detector count rate to exposure rate ratio = 900 cpm per μR/h for Cs-137
- Detector relative response for 700 KeV gamma peak = 0.9
- Approximate gamma energy for Ra-226 plus daughters = 700 KeV
- Scan rate = 0.25 m/s (10 in/s)
- Index of sensitivity (d') = 1.38
- Surveyor efficiency (p) = 0.5
- Observational interval (i) = 2 sec
- Distance of detector from the ground = 15 cm

- Instrument efficiency (ε_i) = determined by calculating the detector exposure rate at 5.9 pCi/g ($DCGL_W$ plus background)
- Surface efficiency (ε_s) =1 (no reduction for gamma radiation)

Based on site specific variables, the scan MDC calculations are as follows for a Class 2 survey unit.

Step 1. Calculate the expected background counts (b_i) in the observation interval (i). The equation is as follows:

b_i = background rate x i x 1 min/60 sec

The equation is solved with example site specific variables as follows:

b_i = 9,000 counts/min x 2.0 sec x 1 min/60 sec = 300 counts

Step 2. Calculate the minimum detectable number of net source counts (s_i) using the following equation:

$$s_i = d'\sqrt{b_i}$$

The equation is solved with the site specific variable as follows:

$$s_i = 1.38\sqrt{300}$$
$$= 23.9 \text{ counts}$$

Step 3. Calculate the minimum detectable count rate (MDCR) using the following equation:

MDCR = s_i x 60 sec/min x 1/i

The equation is solved with the site specific variables as follows:

MDCR = 23.9 counts x 60 sec/min x 1/2.0 sec
= 717 cpm

Step 4. Calculate the MDCRsurveyor using the following equation:

MDCRsurveyor = MDCR / $\sqrt{p}$

The equation is solved with the site specific variables as follows:

MDCRsurveyor = 717 cpm / $\sqrt{0.5}$
= 1,014 cpm

Step 5. Calculate the dose coefficient for exposure to contaminated soil at a depth of one centimeter (cm) for Ra-226 and daughters using Federal Guidance Report No. 12, External Exposure to Radionuclides in Air, Water, and Soil (EPA-402-R-93-081).

Step 5a. Calculate the total dose coefficient for significant gamma emitting daughter products of Ra-226.

The significant gamma emitting daughter products of Ra-226 are lead (Pb)-214 and bismuth (Bi)-214. The dose coefficients are:

Pb-214 = 1.57×10^{-18} Sv/s per Bq/m^3
Bi-214 = 9.15×10^{-18} Sv/s per Bq/m^3

The total dose coefficient is:

Total dose coefficient = 1.57×10^{-18} Sv/s per Bq/m^3 + 9.15×10^{-18} Sv/s per Bq/m^3
= 1.072×10^{-17} Sv/s per Bq/m^3

Step 5b. Convert the units to conventional units (mrem/yr per µCi/g) using the conversion factor of 1.868×10^{23} (soil density independent).

Total dose coefficient = 1.072×10^{-17} Sv/s per Bq/m^3 x 1.868×10^{23} mrem/year per µCi/g / Sv/s per Bq/m^3
= 2,002,496 mrem/yr per µCi/g

Step 5c. Convert the total dose coefficient to conventional units for soil concentration (pCi/g) and to conventional exposure rate units of mrem/hr as follows:

Total dose coefficient = 2,002,496 mrem/yr per µCi/g x 1 µCi/10^6 pCi x 1 yr/8,760 hrs
= 0.0002286 mrem/hr per pCi/g

Step 5d. Calculate the exposure rate at the DCGL$_W$ (5.0 pCi/g) plus background (0.9 pCi/g) as follows:

Exposure rate = 0.0002286 mrem/hr per pCi/g x 7 pCi/g
= 0.00160 mrem/hr

Step 5e. Convert the exposure rate to conventional exposure rate units for field portable detectors (µR/hr) as follows:

Exposure rate = 0.00160 mrem/hr x 1,000 µR/hr per mrem/hr
= 1.60 µR/hr

Step 6. Calculate the detector response to Ra-226 and daughters in equilibrium. Ra-226 and daughter have approximate gamma radiation energy of 700 KeV. Ludlum reports the detector response to Cs-137 at 900 cpm per µR/hr with a response curve that indicates a 0.9 relative response for 700 KeV. Thus the detector response for RA-226 plus daughters is as follows:

Detector response = 900 cpm per µR/hr x 0.9
= 810 cpm per µR/hr

Step 7. Calculate the detector response for the exposure rate determined in Step 5 as follows:

Detector response = 810 cpm per μR/hr x 1.60 μR/hr
= 1,296 cpm

Step 8. Compare the detector response to Ra-226 surface contamination with the MDCRsurveyor determined in Step 4 (1,014 cpm).

Detector response of 1,296 cpm is greater than the MDCRsurveyor value of 1,014 cpm thus a Ludlum Model 44-10 can detect 7.0 pCi/g Ra-226 in surface soil.

Step 9. Calculate the scan MDC.

Step 9a. Calculate the detector response (μR/hr) for the MDCRsurveyor. The equation is as follows:

Detector response = MDCRsurveyor / detector response for Ra-226 plus daughters
The equation is solved with example site-specific variables as follows:

Detector response = 1,014 cpm / 810 cpm per μR/hr
= 1.25 μR/hr

Step 9b. Calculate the scan MDC using the following equation:

Scan MDC = ($DCGL_W$ + Ra-226 background) x detector response (Step 9a) / exposure rate (Step 5e)

The equation is solved with example site specific variables as follows:

Scan MDC = 7.0 pCi/g x 1.25 μR/hr / 1.60 μR/hr
= 5.48 pCi/g

For Class 1 survey units, the scan MDC is determined as described above with one additional step. The area factor for the survey unit is used to determine the $DCGL_{EMC}$. The area factor is calculated from the RESRAD, Version 6.3 program for Ra-226. The 30 year total dose per year for an area of contamination of 10,000 square meters (m^2) is compared to the 30 years total dose per year for an area of contamination based on the sampling grid used in the survey unit. The area of contamination is determined by the following equation:

$$A = 0.866 \times L^2$$

Where A = area of the contamination between sampling points in m^2
L = length of grid, for a triangular grid in meters

The dose for the 10,000 m^2 area is divided by the dose calculated based on the area of contamination between sampling points (as described above) which is equal to the area factor. The $DCGL_{EMC}$ is then calculated based on the following equation:

$$DCGL_{EMC} = DCGL_W \times \text{area factor}$$

For example, the 30 year total dose per year for 10,000 m^2 for Ra-226 is 0.3753 mrem/year. The 30 year total dose per year for 30 m^2 for Ra-226 is 0.2188, thus the area factor is determined as follows:

$$\text{Area factor} = 0.3753 / 0.2188 = 1.7$$

Then the $DCGL_{EMC}$ is determined as follows:

$$DCGL_{EMC} = 5.0 \text{ pCi/g} \times 1.7 = 8.5 \text{ pCi/g}$$

The scan MDC for a Class 1 survey can be determined based on the $DCGL_{EMC}$; i.e. the scanning survey is designed to measure contamination below the $DCGL_{EMC}$ instead of the $DCGL_W$.

Background Determination

The contaminant, Ra-226, is naturally occurring in background surface soil. Therefore, background activity for Ra-226 and gross gamma radiation will be established from areas not affected by site operations. Background samples were collected during the RSE and were analyzed for Ra-226 and gross gamma radiation.

Posting Plot

A primary assumption of the design of the FSS Sampling Design Plan is that the contamination is uniformly distributed throughout the survey unit. To document that the assumption is valid, a posting plot will be created. A posting plot is a graphic illustration of measurements in a survey unit. A posting plot may be conducted by collecting static measurements along evenly spaced transects (e.g., 1 meter apart) using a Ludlum Model 2241-2 ratemeter with a Ludlum Model 44-10 NaI scintillation detector coupled with a Trimble GPS unit. The ratemeter/GPS sampling platform will help establish the horizontal extent of radionuclide contamination through the display of real-time survey data in a XYZ coordinate format. The posting plot will provide a graphical illustration of the contamination distribution throughout the area of investigation.

Data Assessment

Two criteria must be met before the survey unit is released for unrestricted use. The soil sample results must comply with the $DCGL_W$, and all EMCs must have been addressed. The evaluation of the data generated from each investigation activity is treated according to MARSSIM requirements.

The first step in the data analysis is to determine if the survey unit meets the release criteria for the $DCGL_W$. If soil sample results, without background subtracted, are less than the $DCGL_W$ of 5.0 pCi/g, the null hypothesis is rejected and the survey unit is released for unrestricted use without further data analysis using the Wilcoxon rank sum (WRS) statistical test. If any results exceed the $DCGL_W$, the WRS test will be performed. If Wr, the sum of the adjusted reference area ranks from the WRS test, is greater than the critical value, the mean concentration of Ra-226 in soil is less than the $DCGL_W$ and the null hypothesis is rejected. However, if the Wr is less than the critical value, the mean concentration of Ra-226 in soil is greater than the $DCGL_W$, the null hypothesis is accepted, and the survey unit is not released. In this case, the survey unit would be investigated further to delineate the areas of contamination with subsequent remediation.

The critical value (Wc) is a function of the Type I error tolerance, which is 0.05 for this investigation, the number of reference area samples (3), and the number of the survey unit samples (13). The Wc is calculated by the following equation:

$$Wc = m(n + m + 1) / 2 + z\sqrt{nm(n + m + 1) / 12}$$

where,

m = number of reference area samples
n = number of survey unit samples
z = (1-α) percentile of a standard normal distribution (MARSSIM Table I.1)

Therefore,

$$\begin{aligned} Wc &= 3(13+3+1)/2+1.645\sqrt{(13)(3)(13+3+1)/12} \\ &= 38 \end{aligned}$$

Whether or not the null hypothesis is rejected (survey unit is released) or accepted (further remediation is required), the power of the WRS should be assessed to determine if the DQOs were achieved. A retrospective power curve will be constructed to evaluate the number of samples collected with respect to the standard deviation of the sample set. The correct number of samples collected can then be validated. If the retrospective power curve indicates that insufficient samples were collected, two possible actions can be taken. The LBGR can be adjusted to change the relative shift that corresponds to the actual number of samples collected, assuming that the mean of the results is not greater than the LBGR or additional samples can be collected.

The second step in data assessment is the review of scanning measurements. Any detection of an EMC during scanning or from the discrete sampling will require further investigations to delineate the contamination. The contamination will be remediated and the survey unit will be reclassified as a Class 1 survey unit. If less than a 100% scan had been performed, remaining portions of the survey unit would require scanning surveys. Since the surface soil survey unit will be scanned at 100%, additional scanning surveys would not be required after the EMCs were confirmed remediated. However, no additional sampling would be required if the survey unit met the $DCGL_W$ release criterion.

The final review of data will involve a visual interpretation of the posting plot to determine if any patterns in the gross gamma radiation levels indicate a non-homogenous distribution of contamination. Locations that exceed the EMC release criteria will be flagged for further investigation.

ATTACHMENT D

AIR MONITORING SPREADSHEET

LLD Calculation [This verifies that the count times used for the samples are within the LLD for the action level.]

LLD (uCi/mL)= 2.01E-13

Ra-226 action level (uCi/mL)= **9.0E-13**

[10CFR20 App B, Table 2, Col 1] [100 mrem public dose limit]
(this would be the dose for an entire year at this concentration and has additional factors to protect sensitive populations)

R_B	1	Background Count Rate (cpm) - [for alpha drawer ~1 cpm]
t_b	1	The count time of the Background result above, in minutes
t_s	1	Sample count time in minutes
	1800.0	Sample Volume from the Radeco (ft^3)
	5.10E+07	Volume conversion to mL (28,320.6 mL per ft^3)
	0.36	Efficiency of the alpha drawer counter (~37% for 4-pi)
	0.9	Self absorption correction factor
	0.9997	Filter collection efficiency
	2.22E+06	conversion factor for dpm per micro-Curie

$$MDA = \frac{2.71 + 3.29\sqrt{R_B t_S\left[1+\frac{t_S}{t_B}\right]}}{t_S E}$$

$$LLD = \frac{2.71+3.29\sqrt{R_B t_S\left[1+\frac{t_S}{t_B}\right]}}{(t_S)(E_D)(E_F)(FF)(SAF)(Vol_{CC})(2.22E6)}$$

Calculating Detection Limits: MDA & LLD
Jim Mitchell, EPA R5

"Approximation" of radium concentration derived from 2 counts taken at 4 hours and 24 hours following the end of the air sample

This approximation accounts for the buildup of radon decay products on the sample filter and gives an estimate of the concentration of non-radon decay products on the filter. It should be similar to the final results once all radon decay products have decayed away (approx 4.5 days).

5.13E-13 uCi/mL
14 cpm

$$C = \frac{C2 - C1\ exp(-0.0654 * \Delta T)}{(1 - exp(-0.0654 * \Delta T))}$$

	11/1/07 7:00 AM	Begin air sampling (mm/dd/yy hh:mm) [enter as military time]
	11/1/07 4:30 PM	End air sampling (mm/dd/yy hh:mm) [enter as military time]
	1200.0	Sample Volume from the Radeco (ft^3)
	3.40E+07	Volume conversion to mL (28,320.6 mL per ft^3)
	9:30	Calculated sample time (hh:mm)
	0.37	Efficiency of the alpha drawer counter (~37% for 4-pi) (counts recorded per actual disintegrations occurring, ie cpm/dpm)
	4.5045E-07	Conversion Factor (dpm to uCi) ((dpm x 1E6 uCi/Ci) / (60 sec/min * 3.7E10 Ci/dps))
C_1	300	(cpm) Results of Count #1 (Ludlum 3030 Alpha Drawer value). Take about 4 hours after sampling.
	11/1/07 8:00 PM	Time of Count #1 (mm/dd/yy hh:mm) [enter as military time]
	3:30	Elapsed time in (hours:minutes) between end of sample and Count #1. (This should be at least 4 hours!)
C_2	100	(cpm) Results of Count #2 (Ludlum 3030 Alpha Drawer value). Take about 24 hours after sampling.
	11/2/07 2:25 PM	Time of Count #2 (mm/dd/yy hh:mm) [enter as military time]
	18:25	Calculated elapsed time between Count #1 and Count #2 (hh:mm) (This should be about 20 hours!)
ΔT	18.42	Delta T (decimal format)

Post Radon Decay - Final Concentration Calculation
Final Count from Air Sample (above)
<u>Must be counted 4.5 days after end of sample</u>

3.22E-13 uCi/mL

9 (cpm) Results of final count (Ludlum 3030 Alpha Drawer)